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MATHEMATICS AS FOUND IN SOCIETY: WITH CURRICULUM PROPOSALS

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The curriculum of the future must find its justification in the needs existing in society. Those who will determine the curriculum will be men of extensive vision who can feel the pulse of social needs. The so-called subject-matter specialist, by the very nature of his specialization, is not in a position to settle the place of his subject in the curriculum—but once the sociologist determines that any subject should be found in the curriculum and specifies the objectives that should govern it, then it is the place of the subject-matter specialist to arrange the subject matter and the methods of teaching.

But it is not possible to start with a clean slate in curriculum making. We already have a working curriculum, more or less founded on social needs, more or less founded on tradition. We cannot scrap the curriculum—we must change it to more truly satisfy social objectives.

It is the purpose of this paper to state the uses of mathematics as found in society and hence to make curriculum proposals. But as stated above, such proposals must wait for relative valuations between different subjects by wide visioned sociologists before any recommendations by subject-matter specialists can be considered as final.

The population figures below (intended to cover territorial United States) are the roughest of estimates for purposes of comparison only.

1. MATHEMATICAL RESEARCH

There are a number of individuals, both men and women, who are on the frontier of the science of mathematics, conducting research and investigation. Their number may be estimated at 8,000. They are probably nearly all found in some institution of higher learning, either as instructors or as advanced students. Some few may also be research experts in science or industry who further mathematical knowledge in the course of their work. To these is entrusted the most essential burden of carrying on and furthering the great body of mathematical knowledge, so much of which has been used as the very foundation of our civilization. These people are very superior in intellect, although many of them excel predominantly in capacities or powers of a special analytic nature.

II. Mathematics Applied

A second group consist, of those in essentially mathematical occupation, such as inventors, engineers, statisticians, surveyors, scientific men, astronomers, accountants, and research workers in manufacturing, industry, construction, and architecture, who intelligently use and apply the already developed mathematics, but do not necessarily strike out into new mathematical fields. In this group I place all those who make use of mathematical principles in different occupations essentially mathematical in character. These all are high in general intelligence, and especially in analytic ability. They are essential in our modern specialized society. Their number is placed at 80,000.

III. Computing and Drafting

A third group consists of those who perform more or less mechanical mathematical tasks, as computers, cost computers, draftsmen, and bookkeepers. Such are found in banks, offices, and laboratories, wherever computing, drafting or drawing is done. In this group I place those who calculate, compute, read from tables and make tables, use calculating machines and instruments, and in general carry out the directions which have at some time or other been worked out by such as are in group two. These have medium to high intelligence, but have good mechanical ability in the processes of computation, tabulation, drawing, etc. Their number is estimated at 300,000.

IV. Mathematical in Non-Mathematical Occupations

A host of other specialized non-mathematical trades and occupations use mathematics to a very limited extent—the arithmetical processes, formulae, graphs, mensuration, computing or measuring instruments, etc. These uses are in the main so specialized that they may be taught by rule or practice with little emphasis on principle or generalized procedure. These workers are of all grades of intelligence and we will estimate their number at 20,000,000.

V. MATHEMATICS FOR CONSUMERS AND USERS

This group is nearly universal in extent. It consists of those who use mathematics as consumers and users—for buying, investing, general reading, personal accounts, reading meters, clocks, time-tables, making change, etc.

V. MATHEMATICS FOR FORMING SOCIAL JUDGMENTS

Mathematics is used by many in forming social judgments. This group is steadily becoming larger but at present comprises those of superior intelligence who read and form judgments on facts . Such people are able critically to interpret statistical data through the use of graphs and tables and percentages, and by means of the concepts of the various measures of central tendency, variability, correlation, and reliability. The number in this group may be estimated at 20,000.

VII. MATHEMATICS FOR FORMING BUSINESS JUDGMENTS

In this group are those who think in terms of interest, discount, sinking fund, annuity, amortization, depreciation, foreign exchange, equation of payments, such as are found in business mathematics, in forming their business judgments. The man of business and finance, town and city officials, corporation heads, and others must be able to read fiancial statements and statistics, and to evaluate the result of policies. Their number is estimated at 300,000, although this knowledge has by no means become widespread.

VIII. MATHEMATICS IN SCIENCE

There is a group of students and professional men who find mathematics necessary in the study of the various sciences, such as architecture, physics, chemistry, biology, botany, agriculture, zoology, anatomy, bacteriology, optics, and others. These are estimated at 50,000.

IX. MATHEMATICS IN RECREATION

There are some who find recreation in mathematics—those to whom puzzle columns in newspapers, magazines, almanacs, etc., are addressed (Sam Lloyd puzzles). This group is probably rather small, yet there is always the constant interest and demand. Such persons probably rank high in native intelligence. No attempt is made to estimate their number. This group cannot be called essential, and with the objective *recreation* it is doubtful if recreation experts would recommend that public money be spent for increased proficiency in this direction. This should not be confused with teaching method—mathematical recreations will certainly be used in teaching for the stimulation of interest, yet with quite different objectives in view.

X. TEACHERS OF MATHEMATICS

The group of teachers of mathematics. The justification of this group depends on the settlement of curriculum objectives and values to society. It is a group high in intelligence and its present size may be estimated at 25,000.

XI. MATHEMATICS FOR DISCIPLINE

There is at present a large group to whom mathematics is taught as a means of giving command of scientific method or reasoning ability, or inculcating ideals of thrift, accuracy, neatness, thoroughness, etc. It is doubtful whether, if these values were directly sought, mathematics would be chosen as the medium of approach.

XII. MATHEMATICS IN BEAUTY

Mathematics is the foundation of beauty—and its forms are used in architecture, church decóration, and patterns of all kinds. Symmetry is a fundamental element in beauty. The circle, ellipse, square, and star are forms freely used in art. But it is doubtful whether any class or group of individuals use these facts except a very few designers ,architects, etc. They may be numbered at 5,000.

XIII. MATHEMATICS IN RELIGION

For a few the concepts of mathematics, such as the infinite, have a religious significance. This group is undoubtedly small and consists of men who are already grounded in mathematics for other reasons. As such abstract conceptions are merely contemplative and rarely functional, it is questionable whether mathematics need be fostered for this purpose.

Besides these "uses" of mathematics, there is a general diffusion of appreciation among the educated of what mathematics has done in the past and the place it plays in modern civilization, in beauty, in nature, etc.

CURRICULUM PROPOSALS

The foregoing states the various uses of mathematics in society at present. Probably no effort should be spent in training for the objectives of group IX, XI, XII, and XIII. In these groups mathematics is only a means of achieving some other end, and it would have to be shown that mathematics is the best means to the accomplishment of these ends before they can serve as objectives for mathematical study. That is, it must be shown that mathematics is important to recreation or discipline ,or that it functions in religion or that a knowledge of it is of great use in the production of beauty.

Groups III and IV are specialized and vocational and should be cared for in vocational education. But a foundation of the arithmetical processes must be laid in the grades. Really these groups do not learn mathematics at all, but only the mechanical applications of mathematics—the principles underlying the processes need not be taught.

Groups V and VI are or should be universal and minimum standards and more detailed objectives should be set up.

Groups I, II, VII, VIII, and X have a more or less general use for mathematics, and these groups are the ones to be provided for by our schools and colleges. Nearly all of these go on to higher education, and there is a question as to whether all of their mathematics can be left until the choice of a vocation is made, or whether some of it should be learned before a definite choice is made. Probably there is no psychological reason why such a choice need be made at any specific age. But it is a great advantage to have the tools in readiness when the vocation is decided upon.

However, there are a few ways of sifting out those who are possible candidates for these important and essential posts in society. In the first place, they are of high general intelligence almost without exception. Moreover, they all have powers of analysis or generalization far above the common. The general intelligence measurement problem is being successfully solved at present, and a little has been done on the prognostic test. It would be possible, then, to single out with considerable accuracy those who would occupy these important posts and strongly to advise them with regard to an early choice. This would by no means exclude those who would also choose to elect this work and who might achieve a measure of success through diligence.

There have emerged three great divisions into which mathematical instruction should fall. (1) Mathematics that one uses as consumer in everyday living and that is necessary to correctly evaluate and judge society. This should be for all. (2) Mathematics used in the various vocations, usually as skills or habits. This is very specialized for each of the many lines of activity. (3) Mathematics for the essentially mathematical worker, with ability to reason in new situations.

Just a word in closing with reference to the mathematics in the junior high school, which is now the storm center of curriculum changes. The junior high school may disregard (2), since that belongs primarily to the vocational school. A course in (1) might be required of all. Such a course in consumer's mathematics would include topics such as personal accounts, meter reading, budgets, making change, discount, bills, interest, banking practice, checks, promissory notes, reading maps and drawing to scale, interpretation of graphs, train fares, parcel post rates, express rates, insurance, building and loan associations, taxes, etc. Special courses might be given to special groups such as girls (household accounts, budgets, heating expense, buying, food values, ventilation etc.), or for children in farm communities (farm accounts, farm records, planting, feeding, soils, roads, etc.). Again a course might be given for all on the forming of social judgments on facts. Some of the elementary statistical concepts would be taught such as the different averages, the frequency distribution, variation, correlation, etc. Instruction would be given against basing judgment on subjective standards. Effort would be made to enable future citizens to evaluate and criticize social policies, acts of legislation, the news, etc. And in all this, the policy should be prodigality rather than parsimony, as social conditions are rapidly changing and it is impossible to foresee possible arithmetical needs of the common man in the future.

Finally a course in (3) should be offered as an elective, open to any who might wish to choose it, and to which those with suitable talents would be strongly recommended. Such a course or courses would be given with the idea of use or functioning all through life. In algebra such a course would include such topics as the formula, the graph, positive and negative numbers and the equation, also intuitional geometry (or demonstrative when facts can be more easily and surely verified by the student), and numerical trigonometry.

Now in such a course the wise teacher will seek to include all the other values of mathematical instruction as by-products. He will endeavor to raise an appreciation of the place of mathematics in the life about us; he will show the recreational side that mathematics offers; he will, where possible, show where mathematics is the foundation of all forms of beauty; he will show how mathematics helps us to comprehend some of the eternal values of life; he wil develop correct habits of thought and work.